Simulation of Seismograms in Vertical Array at Port Island during the 1995 Hyogoken-Nambu (Kobe) Earthquake

Mostafa Thabet[1]; Hiroo Nemoto[1]; Koichi Nakagawa[2]

[1] Geosciences, Osaka City Univ.; [2] Geosci., Osaka City Univ.

The Hyogo-ken Nambu (Kobe) earthquake occurred at 5:47am on January 17, 1995, and shook the Port Island area with peak horizontal acceleration in excess of 500 gals measured at the Port Island vertical instrument array. During this shaking, many susceptible areas liquefied, including the uncompacted fill within the Port Island vertical array soil profile.

In the present study, the observed records of before, during and after Hyogo-ken Nambu earthquake were examined. It is observed that both the amplitude and the frequency content of the horizontal components are strongly dependent on the shaking level. The investigations provide further evidence that during the mainshock event the liquefaction occurred within the uncompacted fill (0 m to 16 m depth).

From the stand point of the aforementioned investigations, nonlinear analyses were carried out for the mainshock event using hyperbolic failure-seeking model (Pyke, 1979). The 16 m horizontal components were used as imposing motion for the simulation analysis. Firstly, a maximum shear strength value of 7.24 E08 dyn/cm2, average shear wave velocity of 160 m/s and 1% damping ratio were used. High agreement between the simulated and observed can be set until 14.28 seconds. With decreasing shear strength value to 6.6 E08 dyn/cm2 and average shear wave velocity to 48.5 m/s and increasing damping ratio to 8%, high agreement between the simulated and observed can be set between 14.28 to 16.1 seconds. Further decreasing in shear strength value to 1.6 E08 dyn/cm2 and increasing in damping ratio to 30% with the same average shear wave velocity of 48.5 m/s, high agreement between the simulated and observed can be set from 16.1 seconds and later. This degradation process is logically seen during large strains. After that, weighted functions were used to assess the influence of liquefaction. The approach used in this evaluation is to multiply each simulated motion by a weighted function to eliminate the misfit part in the simulated motion. Moreover, those weighted functions characterized by at each time step, the summation for all weighted functions used are 1. The final summed weighted simulated horizontal motions are in high agreement with the observed records.

After that, the author focused on the upper four layers trying to know the shear wave velocity structure variations in this part using before and after mainshock events. For this purpose, average shear wave velocities were calculated using the delay times for S-waves between each two different levels. Then different combinations for shear wave velocity structure were calculated depending on shear wave velocity range for soft soils. After that, 1-D FEM simulations were carried out. Finally, velocity structure combination was selected that represent the most fit simulated with the observed. The results of this approach show that shear wave velocities of the second and the third layers (5m to 27m depth) are reduced after the mainshock.